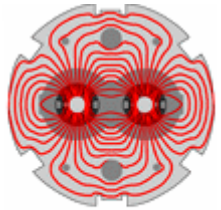
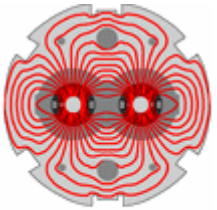


LHC Accelerator Requirements

Elvin Harms/FNAL

July 21, 2005

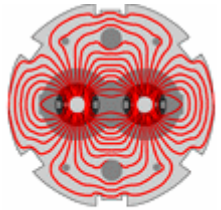
Requirements Review



Schedule for the July 21 Review:

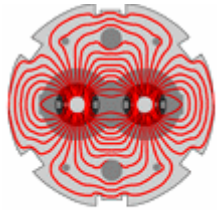
- 7:30 am Executive session
- 8:00 am Introduction to LHC@FNAL (Erik)
- 8:10 am CMS Detector Requirements (Patty)
- ➢ 8:50 am LHC Accelerator Requirements (Elvin)
- 9:30 am Executive session

Introduction



- Key players
- LHC Assumptions
- Scenarios
- LHC Requirements
- Joint Requirements
- Summary

Key Players

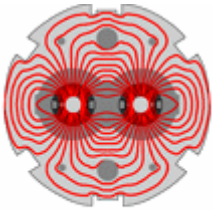


LARP

Key Players

- Suzanne Panacek (CD)
- Elvin Harms (AD)
- Mike Lamm (TD)
- Mike Lamont (CERN)
- Elliott McCrory (AD)
- Jean Slaughter (AD)
- Counsel from
  - **Roberto Saban, Markus Albert, Guy Crockford (CERN)**

Assumptions



LARP

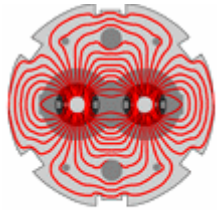
For LHC

- Individuals working in a Field Control Room (FCR) in the LHC tunnel will have access to telephone communications with international calling capabilities.
- Individuals working at the CERN Control Centre (CCC) will have access to telephone communications with international calling capabilities.
- US/LARP personnel will be at CERN to coordinate activities between the CCC and LHC@FNAL.
- The degree to which LHC@FNAL users have access to the LHC control system will be determined by LHC management.
- The LHC will have a shift schedule and a protocol that defines the roles and responsibilities of CCC shift personnel.
- The LHC will have a protocol that defines how machine commissioning and development activities are scheduled and carried out.

For both CMS & LHC

- LHC@FNAL will comply with all CERN and Fermilab safety and security standards.

Scenarios



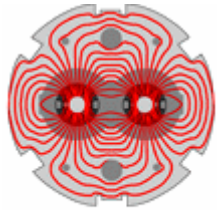
LARP

Six Scenarios were conceived and discussed

They covered key aspects of LHC commissioning and operation

- **Hardware commissioning of a U.S./LARP deliverable**
- **Software contributions to LHC**
- **Beam studies from both CERN and U.S. perspectives (2)**
- **Diagnostics contributions to LHC via LARP**
- **First beam**

LHC Requirements



LARP

Four broad categories of Requirements – requirements scale up as scope of activity changes

- **Overarching (defined as 'to extend over or throughout')**
  - **Confidentiality**
  - **Space**
- **Hardware Commissioning**
  - **Access to data as U.S. hardware – magnets and instrumentation is installed and commissioned**
  - **Link to Field Control rooms in LHC tunnel**
- **Beam Commissioning**
  - **More activity in CCC**
  - **Software development**
  - **Sector test**
  - **First beam**
- **Post-LHC commissioning activities**
  - **Support of LARP deliverables**
  - **Beam studies**
  - **LHC upgrades**

LHC Requirements

LHC Requirements

Overarching	**2 – 1.** LHC Confidentiality	Essential	Proposed–EH
	2 – 2. Enforcement of LHC Confidentiality	Essential	Proposed–SP
	2 – 3. LHC Space	Essential	Proposed–PM
Hardware Commissioning	**2 – 4.** LHC Hardware Commissioning Data Access [126]	Essential	Proposed–MJL
	2 – 5. LHC Hardware Commissioning Logbook [126]	Essential	Proposed–MJL
	2 – 6. FCR Communications [126]	Essential	Proposed–MJL
	2 – 7. FCR Shift Personnel [126]	Essential	Proposed–MJL
	2 – 8. LHC Hardware Commissioning Timescale [126]	Essential	Proposed–MJL
Beam Commissioning	**2 – 9.** LHC@FNAL Consoles [120] [138] [213]	Essential	Proposed–SP
	2 – 10. LHC Data Access [128] [138] [178]	Essential	Proposed–EM
	2 – 11. LHC Configuration Access [178]	Essential	Proposed–ML
	2 – 12. LHC Daily Schedule Meetings [138] [213]	Essential	Proposed–EH
	2 – 13. CCC Communications [120] [128] [138] [178][213]	Essential	Proposed–EM
	2 – 14. CCC Communications Channels [120]	Essential	Incomplete–SP
	2 – 15. LHC Shift Personnel [128] [213]	Essential	Proposed–EM
	2 – 16. CCC Software [120] [178]	Essential	Proposed–SP
	2 – 17. CCC Software Maintenance [120]	Essential	Proposed–SP
	2 – 18. CCC Console Layout [120]	Essential	Proposed–SP
	2 – 19. LHC Development Environment [120] [178]	Essential	Proposed–SP
	2 – 20. LHC Data for Testing [120]	Essential	Proposed–SP
post-Commissioning activities	**2 – 21.** Beam Study Proposals [128]	Essential	Proposed–EM
	2 – 22. Beam Study Protocols [128]	Essential	Proposed–EM

LHC Requirement 2-13

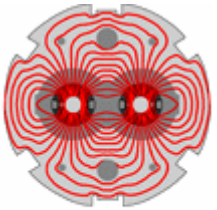
5 scenarios referenced

2 – 13. CCC Communications [120] [128] [138] [178][213]	Essential	Proposed–EM
Several types of reliable 2-way communications shall exist between the CCC and LHC@FNAL. The types of communications shall include, but not be limited to: • Telephone (wired and wireless) • On-demand video conferencing • Simple, prompt electronic messaging with audio alerts (for example, "instant messaging") • E-mail • Electronic logbook		

for example, Scenario 138:

http://docdb.fnal.gov/CMS/DocDB/0001/000138/008/Scenario-Schottky_08.doc

LHC Requirements - Overarching



LARP

3.2. LHC Accelerator Requirements

Requirements that are exclusively LHC requirements are presented in this section, while CMS/LHC combined requirements are presented in Section 3.3 and constraints in Section 3.4. After presenting three important requirements (*LHC Confidentiality*, *Enforcement of LHC Confidentiality*, and *LHC Space*) at the beginning of this section, the remainder of the section is subdivided into three subsections that present requirements for hardware commissioning, beam commissioning, and post-commissioning activities. Requirements for hardware commissioning (Subsection 3.2.1) must be satisfied early on to support installation and commissioning of LHC accelerator components. Additional requirements for beam commissioning (Subsection 3.2.2) and post-commissioning activities (Subsection 3.2.3) can be satisfied at a later time.

2 – 1. LHC Confidentiality	Essential	Proposed–EH
Data, results, conclusions, and problem reports for hardware commissioning, as well as commissioning and operating the LHC shall be kept confidential by all LHC@FNAL users. Only CERN has the authority to release this information to an outside party. Mailing lists and web pages will be protected with passwords and logins.		

2 – 2. Enforcement of LHC Confidentiality	Essential	Proposed–SP
Fermilab management and LARP management shall be responsible for enforcing the LHC confidentiality agreement.		

2 – 3. LHC Space	Essential	Proposed–PM
LHC@FNAL shall have the space that is needed to accommodate US/LARP activities, particularly during LHC hardware commissioning, beam commissioning, operations, and beam studies.		

CERN will dictate what information LHC@FNAL can and cannot disseminate. Enforcement will be done by the organizations here.

Space will be needed to carry out LHC@FNAL activities during all phases.

LHC Requirements – Hardware Commissioning

3.2.1. Requirements to Participate in LHC Hardware Commissioning

Requirements for LHC hardware commissioning are presented in this section. The primary focus is on access to information and communications, specifically communications with personnel in a CERN Field Control Room (FCR) since initial hardware commissioning will occur exclusively in this venue. During hardware commissioning LHC@FNAL users will be active, remote participants to help commission U.S.-provided magnets and assist with diagnostics. This implies a need to be as involved as possible in commissioning meetings, and to have access to numerous means of communication to be able to exchange information with people who are engaged in commissioning activities at CERN.

2 – 4. LHC Hardware Commissioning Data Access [126]	Essential	Proposed–MJL
LHC@FNAL shall have read access to hardware commissioning data. This shall include, but not be limited to: • Quench data • Slow-monitoring data such as thermometry and liquid level gauges		

2 – 5. LHC Hardware Commissioning Logbook [126]	Essential	Proposed–MJL
LHC@FNAL shall have read and write access to the hardware commissioning logbook.		

2 – 6. FCR Communications [126]	Essential	Proposed–MJL
Several types of reliable communications shall exist between a Field Control Room (FCR) and LHC@FNAL. The types of communications shall include, but not be limited to: • Telephone (wired and wireless) • Simple, prompt electronic messaging with audio alerts (for example, "instant messaging") • E-mail • Electronic logbook		

2 – 7. FCR Shift Personnel [126]	Essential	Proposed–MJL
LHC@FNAL personnel shall know who is on shift at the FCR, and they shall know the roles and responsibilities of the FCR shift personnel.		

2 – 8. LHC Hardware Commissioning Timescale [126]	Essential	Proposed–MJL
The timescale for hardware commissioning aspects of LHC@FNAL shall match the LHC schedule for hardware commissioning. Full implementation shall be completed by June 2006.		

Data access is necessary.

Read/write access to log books is necessary.

Communication with personnel in Field Control Rooms will be essential.

FCR Shifters will be identified and their roles known.

Early involvement is vital.

LHC Requirements – Beam Commissioning

3.2.2. Requirements to Participate in Beam Commissioning

Requirements for LHC beam commissioning are presented in this section. Compared to requirements in the previous section on hardware commissioning, the following requirements focus on duplicating some of the functionality that is available at the CERN Control Centre (CCC), such as access to information that is available to someone working at the CCC. Just as

3.2.2.1. Access and Communications

2 – 9. LHC@FNAL Consoles [120] [138] [213]	Essential	Proposed–SP
LHC@FNAL shall have the same or equivalent consoles installed as the CCC.		

2 – 10. LHC Data Access [128] [138] [178]	Essential	Proposed–EM

LHC@FNAL shall have prompt read access to LHC accelerator data. This shall include, but not be limited to:
• Logged machine data
• Machine parameter changes "published" by CERN
• Logged fault data
• Online measurement repository
• Timely data from non-LARP instruments
• All data from LARP-supplied instruments, including (but not limited to):
  ○ scope traces from LARP instrument
  ○ read access to low level processor parameters and system information		

2 – 11. LHC Configuration Access [178]	Essential	Proposed–ML
LHC@FNAL shall have access to LHC optics, errors, and transfer functions. An agreement between CERN and Fermilab ensures that LHC@FNAL has the required access to the appropriate repositories. LHC@FNAL shall also have access to pre-defined measurement data structures, storage and access methods.		

2 – 12. LHC Daily Schedule Meetings [138] [213]	Essential	Proposed–EH
LHC@FNAL shall have access to information and decisions from daily LHC schedule meetings at CERN.		

Consoles as identical as possible to those in the CCC will promote assimilation.

Access to different forms of LHC data available both 'now' and from repositories is essential.

To be fully integrated requires knowledge of daily commissioning plans.

LHC Requirements – Beam Commissioning

2 – 13. CCC Communications [120] [128] [138] [178][213]	Essential	Proposed–EM
Several types of reliable 2-way communications shall exist between the CCC and LHC@FNAL. The types of communications shall include, but not be limited to: • Telephone (wired and wireless) • On-demand video conferencing • Simple, prompt electronic messaging with audio alerts (for example, "instant messaging") • E-mail • Electronic logbook		

2 – 14. CCC Communications Channels [120]	Essential	Incomplete–SP
LHC@FNAL shall have the capability for multiple (**minimum number?**) communications channels that can be used simultaneously.		

2 – 15. LHC Shift Personnel [128] [213]	Essential	Proposed–EM
LHC@FNAL personnel shall know who is on shift at the CCC, and they shall know the roles and responsibilities of the CCC shift personnel.		

Communication through a variety of means between LHC@FNAL and the CCC will be essential.

CCC on-shift personnel will be identified and their roles known.

LHC Requirements – Beam Commissioning

3.2.2.2. Software and Software Development

Several different types of software will be in use at LHC@FNAL, and the requirements depend on the type of software that is being considered. In this section we refer to "LHC accelerator software," which is defined to be project-wide software that is developed for the LHC. See Section 3.4.3 for a description of other types of software, and constraints on software development.

2 – 16. CCC Software [120] [178]	Essential	Proposed–SP
LHC@FNAL shall have the same LHC accelerator software installed as the CCC.		

2 – 17. CCC Software Maintenance [120]	Essential	Proposed–SP
LHC@FNAL shall be administered such that LHC accelerator software is current and maintained at the same version as the CCC.		

2 – 18. CCC Console Layout [120]	Essential	Proposed–SP
The layout of LHC@FNAL consoles shall mirror the CCC console layout.		

2 – 19. LHC Development Environment [120] [178]	Essential	Proposed–SP
LHC@FNAL shall have the software development environment that is needed to develop LHC accelerator software.		

2 – 20. LHC Data for Testing [120]	Essential	Proposed–SP
LHC@FNAL shall have access to data necessary for testing LHC accelerator software.		

Software must be identical and current.

Consoles must be as identical in look and feel as those in the CCC.

It must be possible to access appropriate data to carry out software/applications testing.

LHC Requirements – post-Commissioning

3.2.3. Requirements to Participate in Post-Commissioning LHC Activities

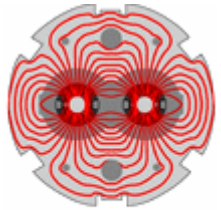
Requirements for participating in post-commissioning LHC activities are *additional* requirements besides the ones listed in previous sections. These activities are expected to include, but are not limited to, remote participation in LHC beam studies, support of U.S.-provided deliverables, and work on LHC luminosity upgrades

2 – 21. Beam Study Proposals [128]	Essential	Proposed–EM
LHC@FNAL personnel shall be able to submit beam-study proposals to LHC management and be notified of their status.		

2 – 22. Beam Study Protocols [128]	Essential	Proposed–EM
The protocol that defines how beam studies at the LHC are carried out shall include LHC@FNAL personnel, and shall include the following: • Methodology for making beam measurements • Methodology for ensuring the validity of measurement data • Ways to insure timely, accurate and complete communication before, during, and after each beam study		

Initiating and participating in beams studies is critical to long-term involvement. Such studies will require discipline in planning and conducting them.

CMS/LHC Requirements

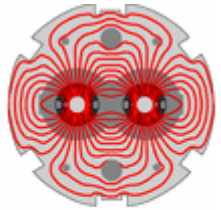


LARP

Two categories of Requirements

- **Common Capabilities**
- **Operational Environment**

CMS/LHC Requirements



LARP

General Capabilities	**3 – 1.** LHC@FNAL Shifts [126] [213]	Essential	Proposed–EH
	3 – 2. LHC@FNAL Record of Shift Schedule	Essential	Proposed–EG
	3 – 3. LHC@FNAL Directory	Essential	Proposed–EG
	3 – 4. LHC@FNAL Web Page	Essential	Proposed–EG
	3 – 5. LHC@FNAL Lifespan [138]	Essential	Proposed–JS
Environment	**3 – 6.** LHC@FNAL Shift Area [213]	Essential	Proposed–EH
	3 – 7. LHC@FNAL Common Area	Essential	Proposed–PM
	3 – 8. LHC@FNAL Display Sharing	Essential	Proposed–EG
	3 – 9. LHC@FNAL Working Area	Essential	Proposed–SK
	3 – 10. LHC@FNAL Social Area	Essential	Proposed–EH
	3 – 11. LHC@FNAL Clocks	Essential	Proposed–EG

Joint Requirements – General Capabilities

3.3. CMS/LHC Combined Requirements

Requirements that involve both the CMS experiment and the LHC accelerator are presented in this section, which addresses general capabilities and features. There are two subsections. The first (Subsection 3.3.1) presents capabilities that are common to CMS and LHC, and the second (Subsection 3.3.2) presents requirements for the operational environment in which both CMS and LHC participants will work.

3.3.1. General Capabilities

3 – 1. LHC@FNAL Shifts [126] [213]	Essential	Proposed–EH
LHC@FNAL shall be staffed as conditions require. The shift schedule (showing shift personnel, time on shift, and contact information), shall be posted so that it can be accessed by CMS and LHC personnel.		

3 – 2. LHC@FNAL Record of Shift Schedule	Essential	Proposed–EG
The LHC@FNAL shift schedule shall be archived and published on-line so that it can be accessed by CMS and LHC personnel.		

3 – 3. LHC@FNAL Directory	Essential	Proposed–EG
LHC@FNAL shall maintain a directory of LHC@FNAL users and their contact information for CMS and LHC personnel.		

3 – 4. LHC@FNAL Web Page	Essential	Proposed–EG
LHC@FNAL shall maintain a web page with information that includes, but is not limited to: • LHC@FNAL operational status • LHC@FNAL shift schedule • LHC@FNAL directory		

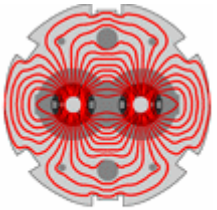
3 – 5. LHC@FNAL Lifespan [138]	Essential	Proposed–JS
LHC@FNAL center shall remain in operation for as long as there are US-CMS and US/LARP commitments.		

LHC@FNAL will be staffed as necessary. Staffing information will be accessible to LHC & CMS.

There will be directory of LHC@FNAL users.

LHC@FNAL will function at least until US-CMS and US/LARP commitments are met.

Joint Requirements – Environment



LARP

3.3.2. Operational Environment

Several different areas are needed to accommodate the diverse activities that are expected to be carried out at LHC@FNAL. One of the unique features of this facility is the close proximity of people working on the LHC accelerator and the CMS experiment. The facility requires space for personnel working on CMS and space for LHC personnel, where someone can work undisturbed on one without interference from activities devoted to the other. We refer to this as the *shift area*. A *common area* is needed where CMS and LHC personnel can work together, and a *working area* provides necessary space for LHC@FNAL users who are not actively engaged in shift activities but need access to capabilities provided by the facility.

3 – 6. LHC@FNAL Shift Area [213]	Essential	Proposed–EH
Space for LHC@FNAL shall include a shift area with CCC and CMS consoles and access to communications for shift personnel as required by **1 – 5** and **2 – 13**.		

3 – 7. LHC@FNAL Common Area	Essential	Proposed–PM
Space for LHC@FNAL shall accommodate a common area where CMS and LHC personnel can communicate with each other while actively engaged in remote activities at CERN.		

3 – 8. LHC@FNAL Display Sharing	Essential	Proposed–EG
To facilitate communication between CMS and LHC, LHC@FNAL consoles shall have the capability of displaying both CMS and LHC data.		

3 – 9. LHC@FNAL Working Area	Essential	Proposed–SK
Space for LHC@FNAL shall include a working area for LHC@FNAL users who are not actively engaged in shift activities. The working area shall provide telephones and internet connectivity.		

3 – 10. LHC@FNAL Social Area	Essential	Proposed–EH
Space for LHC@FNAL shall include a social area with a kitchen facility.		

3 – 11. LHC@FNAL Clocks	Essential	Proposed–EG
LHC@FNAL shall have at least two clocks: one showing the local time at Fermilab, the second showing the time at CERN.		

Shift area – separate space for CMS and LHC.

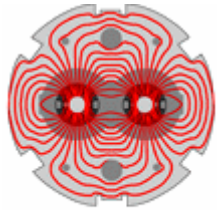
Common space and display capabilities will further joint LHC/CMS work.

A Working area will provide access to capabilities for those not on shift.

With shift work likely, a social area for addressing creature comforts is desirable.

Synchronized clocks will help provide a time context .

Summary



LARP

Preliminary **LHC Requirements are spelled out based on scenarios of expected activities**

- **Extracted from scenarios which attempt to anticipate all major events of the LHC's lifespan**
- **Participation by LARP, CERN, FNAL potential active players**
- **End result is to mirror the CCC for accelerator activities**
- **Provide for joint use by LHC/LARP and CMS**